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A TENTATIVE STUDY OF THE EFFECT OF ROOT EXCRETION OF COMMON PADDY WEEDS UPON CROP PRODUCTION OF LOWLAND RICE.[1]

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INTRODUCTION

Crop rotation does not always insure a better return than that which could be obtained by growing the same crop continuously. The result of the work of W. M. Hays (1) shows that

> "A four-year rotation—millet, barley, corn, and oats—gave no better returns than wheat grown continuously."

The above finding could be explained as being partly due to root excretion. This conclusion is supported by the contention of O. Schreiner and H. S. Reed (2) that

> "In our present state of knowledge it would seem that we must regard the excreta of growing roots as one of the main causes of the low yields obtained in unproper crop rotation."

This is further justified and supported by F. Fletcher, B. E. Livingston, and I. Stocklasa, and A. Ernest (3), (4) and (5) that roots of plants excrete a substance which is injurious to other crops. It appears therefore that root excretion is an important factor in crop production. A knowledge of the kind of crop which should follow another crop in order to get a fair return is undoubtedly valuable information to have for reference. It was the object of this work to find out as far as possible and to try on several kinds of plants the effect of root excretion when the aqueous extract of the soil where the plants are growing is supplied to another crop.

The work was carried out at the College of Agriculture, Los Baños, during the year 1922.

MATERIALS AND METHOD

EQUIPMENT USED

Five petroleum cans, opened at one end and afterwards thoroughly cleaned with water, were used as containers for planting different species of weeds. Another six cans were also prepared for planting rice. To one of the corners at the

[1] Experiment Station Contribution No. 109

bottom of each of the five cans a hole was bored. A single holed rubber stopper was then fitted to each of the holes. Through the hole of the rubber stopper, a glass tube about ten centimeters long was inserted. To its lower end another glass tube about thirty centimeters long was connected to it by means of a piece of rubber tubing provided with a pinchcock. The arrangement and designation of the cultures as well as the method of obtaining the drainage from the can cultures are shown by the following diagrams. See figures 1 and 2. The experiment was carried in quadruplicate cultures.

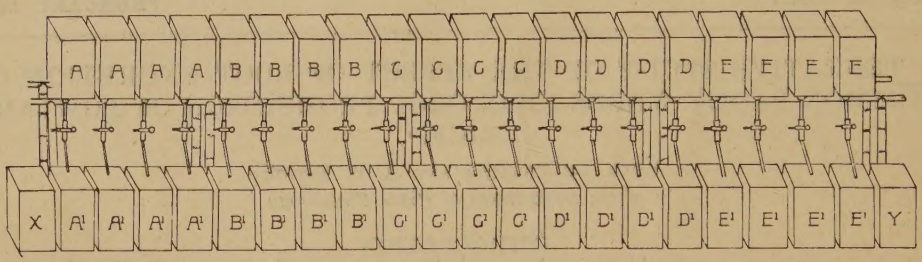

Figure 1, showing arrangement of cultures.

A - Cans without any plant (Blank). A' - Cans planted with rice.
B - Cans planted with rice. B' - Cans planted with rice.
C - Cans planted with zacate. C' - Cans planted with rice.
D - Cans planted with water-lily. D' - Cans planted with rice.
E - Cans planted with Cyperus. E' - Cans planted with rice.
X & Y: Cans planted with rice and watered with top water (Control).

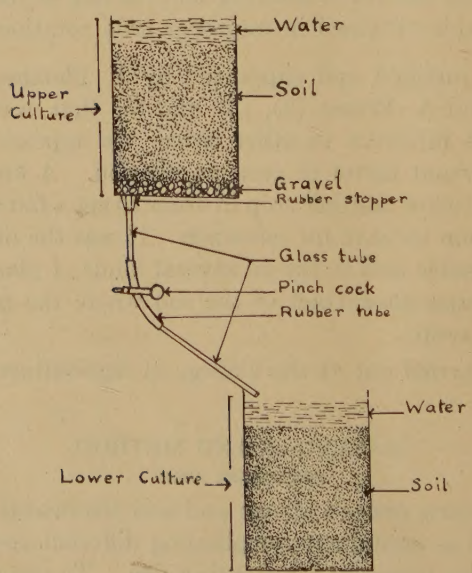

Figure 2.

For clearness, the cans labeled A, B, C, D, and E and placed on the stage as shown in Fig. 1 were designated as "upper cultures." Cans labeled A^1, B^1, C^1, D^1, and E^1 and placed below the upper cultures were likewise called the "lower cultures."

(a) *Kind of soil used.*—A typical garden soil (clay loam) was used for this study. The soil was taken from the college farm just east of the Botany-Physics building of the College of Agriculture. The soil was thoroughly pulverized and afterwards mixed before putting it into the cans. Eighteen kilograms of soil was put into each of the cans in the quadruplicate cultures.

(b) *Plants used and their preparation.*—Zacate (*Leersia hexandra* Sw.), water-lily (*Monochoria hastata* (L) Solms.), *Cyperus* spp. (sedges) and rice (*Oryza sativa* L.) all of which, except rice, are very abundant weeds in paddy fields, were selected from the field and planted in the upper cultures. These can cultures (upper culture) were planted quite thickly as there was room for the plants. The planting was done very much ahead of time before the lower cultures (A^1, B^1, C^1, D^1 and E^1 and XY) were planted with rice. The idea was to have the plants planted in the upper cultures well started for normal development before the rice plants planted in the lower cultures needed water for irrigation. Eight rice seedlings (two weeks old), uniform in height and number of leaves developed at the time of planting were planted to each of the cans in the lower cultures. Later the number of plants in every culture was reduced to two.

A lowland variety of rice was used as subject of this study. It was chosen because rice is the most important cereal in the Philippines. The effect of aqueous extracts obtained from the upper cultures in which zacate, water-lily, *Cyperus* and rice plants were then growing, were tried for watering rice, because the above named plants with the exception of rice practically always grow side by side with rice.

EXPERIMENTAL TECHNIQUE

(a) *Method of watering.*—Since the plants planted in the upper and that of the lower cultures were all aquatic plants the authors tried to maintain a depth of water of from eight to ten centimeters above the surface of the soil in the upper cultures and of from three to five centimeters above the surface of the soil in the lower ones. Water taken direct from the water pipe was used for watering the upper cultures and the lower cultures were in turn watered from the aqueous extracts obtained from the upper cultures as illustrated in Figs. 1 and 2. The cultures labeled X and Y, placed in line with the lower cultures, were set as controls. They therefore were watered with water taken direct from the water pipe.

(b) *Treatment of Cultures.*—All the plants in the lower cultures and labeled "A^1" received drainage from the upper cans labeled "A". In these cans, "A," there were no plants grown in the soil (Blank). Cultures labeled "B^1" received drainage from cultures labeled "B," containing rice plants; cultures "C^1" received drainage from cultures "C" containing zacate plants; "D^1" cultures received drainage from "D" cultures containing water-lily plants; "E^1" cultures received *Cyperus* drainage from "E" cultures; and cultures X and Y were watered with top water (water from pipe). See figs. 1 and 2.

(c) *Criteria considered.*—The total leaf product (length times width), dry weight of straw and grains and height of plants at the time of harvesting the plants from the different cultures were the criteria here considered for this study. The

height and total leaf products were intended to show the vegetative growth of each of the cultures and that of the dry weight of straw and grains were to show the total activity of the rice plants in response to the condition under which the plants were subjected.

RESULTS

The results are presented in tables as follows:

Table I shows the data of the different criteria considered from the individual cultures as affected by different kinds of drainage from different kinds of plants.

Table II shows the average comparative yield of the different cultures receiving different kinds of aqueous extracts as drainage from different kinds of plants.

Table III is a summary table showing gain or loss in leaf product (length times width), dry weight of stalks and grains in grams and total height of plants expressed in percentage of the different cultures watered with different kinds of drainage.

DISCUSSION OF RESULTS

Table II, a condensed table of yield data of the different criteria considered from the different cultures as watered with different kinds of drainage, Table I, shows that water-lily and *Cyperus*, both very common paddy weeds excrete some substances beneficial to rice production. Zacate, the most common forage crop in the Philippines, according to results obtained, gives off some substances deleterious to rice. Likewise, rice excretes substances harmful to rice. This justified the results of S. Pickering that

> "* * * a plant affects its own kind just as much as any other kind; and hence we must conclude that the toxin formed by any individual plant will affect that individual itself."

In order to show the relative effect of the different kinds of drainage obtained from the different kinds of plants upon rice, the results obtained from the different cultures were expressed in percentages. Table III shows the gain and loss in per cent in leaf products, weight of straw and grains, and the height of plants at the time when they were harvested. It should be noted, however, that the cultures drained with water taken direct from the water pipe and labeled top water under the heading, "Sources of extracts as drainage," were the ones considered in this experiment as control. The results obtained from the control cultures were given a value of one hundred per cent. The value of the results obtained from the other cultures as watered from the different kinds of drainage in terms of percentages were obtained as follows.

Test[a] yield divided by control yield multiplied by 100 gives the value of test yield in terms of per cent, thus—Control yield (Top water) leaf product = 371.4 sq. cm. Test (soil drainage) leaf product = 466.7 sq. cm.

$$\frac{466.7}{371.4} \times 100 = 126\%$$

The other criteria were calculated like the above formula. The results of these calculations can be seen in Table III, third column under the heading "Data obtained expressed in per cent".

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a Test in this case means the culture watered with some drainage (aqueous extracts) as soil drainage, rice drainage or zacate drainage.

Having expressed the results obtained in a common unit, direct comparison can now be made. The authors tried only to consider leaf product, dry weight of straw and grains, and height of plants as the different criteria for this study. Before coming to column "gain and loss" we would like to mention the fact that in the soil undoubtedly there are also many kinds of bacteria and also of the lower plants such as algae. These organisms may in the course of the experiment modify the condition of the medium used. If this happens then we have two unknown factors involved, the substance excreted by the roots of plants in the one hand and the working of the soil bacteria, etc., in the other. In order that we could at least separate the effect of the two unknown factors mentioned above we had also set of cultures watered with soil drainage. No plants were allowed to grow in the soil. In this case the extract which we got from it was supposed to contain only the working of soil bacteria, etc., if there is any. The other cans where the different weeds were planted such as Zacate, water-lily, *Cyperus* and that of rice, the drainage which we took from them as aqueous extracts may contain the two unknown factors (Bacteria, etc., and Root excretion). For the present study we found out that by using soil drainage upon rice, the extract increases the leaf products of the plant 26 per cent over the leaf products of the control plants (top water); 62 per cent in dry weight of straw over the control plants; 91 per cent in dry weight of grains over the control plants; and 4 per cent in the height of plants over the control. From these figures it is safe to say that if soil drainage (aqueous extracts) is taken and watered to rice plants, a noteworthy gain could be obtained in any of the criteria mentioned over plants watered with top water.

Having known the effect of soil drainage (the working of soil bacteria, lower plants, etc., in the soil) in terms of percentages upon rice we can proceed to show whether the weeds used in this experiment had excreted some substances beneficial or harmful to rice.

Under the main heading "Leaf product in sq. cm., sub-column, Per cent, gain and loss," Table III, we see that for rice drainage we got a loss of 8 per cent. This figure was obtained by subtracting 26%, the value of soil drainage over the control plants (Top water) from 118, the value of the data from cultures watered with rice drainage, the result of which is 92% (representing the effect of the working of bacteria, lower plants, etc., in the soil) was subtracted from 100% (the value of the yield of the control plants) giving a deficit of 8 per cent. This eight per cent therefore represents a loss upon leaf product by rice if the plants are watered with rice drainage (aqueous extracts). In short, toxic effect of rice upon rice. The other figures under this heading, "Per cent gain and loss" and for the other criteria as for straw, grain and height of plants were calculated like the one just explained. The figures referred to are shown in Table III and graphed as illustrated in Fig. 3.

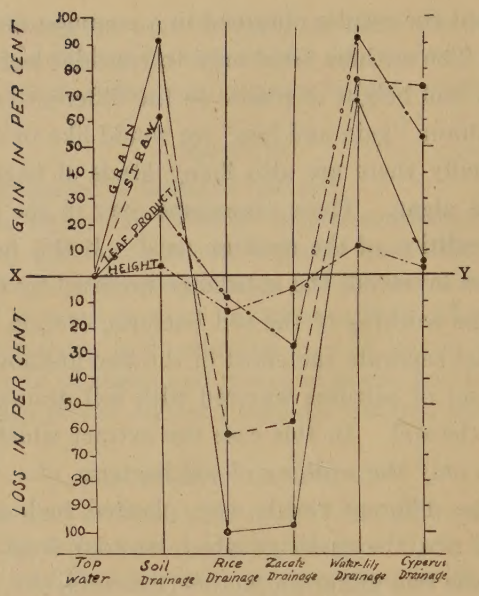

Figure 3.

Fig. 3 shows gain and loss in per cent. For convenience, line XY represents control yield of the four criteria considered, leaf products, dry weight of straw and grain, and height of plants. Any point below line XY shows loss and that points above it also show again. Examination of the graphs of grain, straw, leaf products and height of plants shows that the graphs follow the same trend. Rice and zacate drainage show conclusively that plants excrete some substance deleterious to rice production, while Water-lily and *Cyperus* show a big gain. These results suggest that zacate should not be rotated with rice and that water-lily and *Cyperus* insure a promise of better yield if they are rotated with rice. With special reference to grain yield, rice drainage to rice showed a loss of one hundred per cent in grain production. This is still higher than the effect of zacate drainage upon rice. One hundred per cent loss in grain yield in this case shows the degree of root toxicity of rice upon rice. However the toxicity of root excretion is to some extent counteracted by the working of soil bacteria, etc., as algae in the soil. In this particular experiment, the effect of rice drainage upon rice is reduced to nine per cent. Nine per cent therefore is the actual loss we get for every crop if rice is grown continuously in the same field. This loss is so slightly felt in the field that only after many years have passed do we find that the yield of rice grown in that particular place has depreciated appreciably.

CONCLUSION AND RECOMMENDATION

With regard the results obtained so far show conclusively that *Cyperus spp.* and water-lily (*Monochoria hastata* (L) Solms.) excrete substances beneficial to rice production and that zacate (*Leersia hexandra* Sw.) gives off also substances detrimental to rice production. Rice itself excretes a substance harmful to its own kind. As tentative conclusions of the results of this investigation are concerned, the authors strongly believe the following:

1. If water-lily and *Cyperus*, both very common paddy weeds, were grown in rotation with rice a noteworthy gain in rice production could be obtained.

2. Zacate which is the most common forage crop in the Philippines, should not be rotated with rice.

3. That rice also excretes a substance deleterious to its own kind causing a reduction of 9% in grain yield every planting in the same field, and that

4. Before planting rice thorough plowing and harrowing of the field should be done in order to have the toxic substances destroyed, thus rendering them to some extent harmless to the following crop.

ACKNOWLEDGEMENT

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number of bearing culms, length of panicle and height of stalks obtained from the different kinds of drainage of different kinds of plants.

Soil Drainage			Rice Drainage				Zacate Drainage				Water-lily Drainage				Cyperus Drainage			
Culture Number			Culture Number				Culture Number				Culture Number				Culture Number			
2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
7	4	2	4	4	2	3	3	4	2	4	8	8	6	5	7	5	6	8
4			3.3				3.3				6.8				6.5			
20.5	20.1	9	18.6	17.0	12.2	11.8	18.1	16.5	14	19.1	17.0	19.0	20.8	20.4	21.0	18.0	19.1	18.1
16.4			14.9				16.4				19.3				19.0			
108	102	90	105	109	68	66	94	106	80	102	102	114	113	110	100	104	100	106
99.5			87				95.5				111.5				102.5			
466.7			437.6				366.4				814.0				668.1			
70.8	50.0	25.0	47.0	40.0	10.0	9.0	31.0	39.0	17.0	25.0	52.0	71.2	70.0	53.0	85.2	44.3	49.0	52.0
43.2			27.0				28.0				61.01				57.6			
23.6	10.02	3.9	11.6	7.25	1.55	1.5	5.7	7.4	3.1	4.4	13.3	16.9	12.3	16.7	14.2	9.7	6.4	13.4
10.88			5.47				5.2				14.3				10.9			
20.4	13.5	7.5	13.6	10.0	3.4	3.3	8.9	11.2	3.7	7.7	14.1	22.0	20.5	15.0	26.7	15.0	14.5	14.6
12.2			7.6				7.9				17.9				17.7			
18.4	9.2	5.1	8.95	6.0	1.22	1.2	4.9	6.55	2.35	3.8	10.55	13.9	10.6	13.65	12.4	7.92	5.3	11.04
9.4			4.3				4.4				12.2				9.2			

TABLE II.—*Comparative data of average total leaf products (length times width) in sq. cm., dry weight of straw and grains in grams, total height of culms in cm. and number of bearing culms of quadruplicate cultures as drained by different kinds of aqueous extracts from different kinds of plants.*

Sources of extracts as drainage.	Leaf Products in sq. cm.	Dry Wt. of stalks in gms.	Dry Wt. of grains in gms.	Height of stalks in cm.	Average Number of bearing culms
Top Water	371.4	7.5	4.7	96.0	3
Soil drainage	466.7	12.2	9.4	99.5	4
Rice drainage	437.6	7.6	4.3	87.0	3.3
Zacate drainage	366.4	7.9	4.4	95.5	3.3
Water-lily drainage	814.0	17.9	12.2	111.5	6.8
Cyperus drainage	668.1	17.7	9.2	102.5	6.5

TABLE III.—*A summary table of gain and loss, in leaf products, dry weight of straw and grain, and height of plants of the different cultures as affected by different kinds of drainage from different kinds of plants expressed in percentages by using the data obtained from cultures drained with top water as control and considered to be as 100 per cent.*

Sources of extracts as drainage.	Leaf products in sq. cm.				Dry weight of straw in grams.				Dry weight of grains in grams.				Height of plants in cm.			
	Data obtained.	Data obtained expressed in per cent.	Per cent		Data obtained.	Data obtained expressed in per cent.	Per cent		Data obtained.	Data obtained expressed in per cent.	Per cent		Data obtained.	Data obtained expressed in per cent.	Per cent	
			gain	loss			gain	loss			gain	loss			gain	loss
Top water.....	371.4	100			7.5	100			4.7	100			96.0	100		
Soil drainage.....	466.7	126	26(*a*)		12.2	162	62(*b*)		9.4	191	91(*c*)		99.5	104	4 (*d*)	
Rice drainage.....	437.6	118		8	7.6	100		62	4.3	91		100	87.0	91		13
Zacate drainage.....	366.4	99		27	7.9	105		57	4.4	93		98	95.5	99		5
Water-lily drainage.	814.0	219	93		17.9	238	76		12.2	259	68		111.5	116	12	
Cyperus drainage...	668.1	180	54		17.7	236	74		9.2	196	5		102.5	107	3	

(*a*) Effect of soil drainage upon leaf products.
(*b*) Effect of soil drainage upon dry weight of straw.
(*c*) Effect of soil drainage upon dry weight of grain.
(*d*) Effect of soil drainage upon height of plants.

BREEDING ORNAMENTAL HIBISCUS[1]

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The taste for ornamental plants and the ornamental garden is general among the Filipinos. Even in the most humble home, one may find evidence of this taste. From few to many varieties of plants may be found in a small lot constituting the ornamental garden, usually below the windows facing the street and along paths in the home yard. Where ground space is not available, plants are planted in pots and kept on special supports, sometimes in "azoteas"[2] or even in the windows and houses. The practice of hanging ornamental plants in front of windows is very general. The plants hung are usually orchids, but sometimes any other small type varieties are used. These are planted in pots and cans and then hung. Oftentimes these containers are very ugly, showing the simple taste of the owner. Even germinating corn ears are used as hanging ornamentals.

Excepting in comparatively few cases, this love for ornamental plants is easily satisfied as is evidenced by the fact that the family collection of ornamentals consists usually of very few varieties. The most common hanging plants used are the so-called "bird's nest" fern, *Asplenium nidus* L. and several varieties of orchids belonging to the species *Phalaenopsis* and *Vanda*. In the yard, the San Francisco (*Codiaeum variegatum* (L.) Blume.), the Gumamela (*Hibiscus rosa-sinensis* L.) and *H.schizopetalus* Hook, the Papua (*Panax fruticosum* L.) and Morado or Sarasa (*Graptophyllum pictum* (L.) Griff.) are most commonly grown. Besides these, a great variety of ornamental species is found cultivated in the Philippines. However, they do not go in a typical collection of the average family. One reason other more beautiful plants are not grown in general is that they are not as easy to secure and require greater cultural attention and care.

The greatest service of the plant breeder in the Philippines will probably be in the improvement of the few ornamental species generally grown and the bringing down into cultivation of the various ornamental plants now found in the mountains and the forests.

There is much in the way of ornamental garden improvement in the Philippines which students of Philippine plant breeding should learn besides the improvement of the ornamental plant itself. The beauty of a garden or a yard depends not only on the plants which are found in it but also on the arrangement and grouping of the plants, the contour of the land as well as on other minor factors. It is not the object of this paper to review even briefly the general subject of ornamental and landscape gardening or landscape architecture. It is necessary, however, that students learn some of the very fundamental points in the subjects as far as these may have a close relation to the improvement of ornamental plants. As the subject of ornamental gardening is, quite regret-

[1] Experiment Station Contribution No. 110

[2] Azotea is an open floor usually at the back of the house. A sort of an upper story yard.

tably, no longer taught in the College of Agriculture, although a beautiful and increasingly important garden is maintained, a few pertinent remarks about this are necessary to a proper understanding and appreciation of this paper.

An ornamental plant may serve any one or several of the following purposes: (1) For ornamental pot cultures, (2) for single plant ground cultures, (3) for hanging, (4) for ornamental hedges, (5) for table and mantle purposes, (6) for climbing effects, (7) for hiding undesirable views, (8) for lawns, (9) for mass effects, and (10) for fancy forms.

The first six uses find illustrations in Philippine ornamental gardening. The seventh use is hardly to be seen while the art of lawn making and the growing of lawn trees or plants as well as the art of obtaining beauty from special grouping or arrangement of plants and from pruning to get different forms of growth are practically unknown.

In many of the above uses, it is difficult to tell what characteristic appearance a plant should have. Much depends upon the taste of the grower. However, it is possible for a breeder to ascertain in each given case just what is desired of the ornamental plant. It is also practically certain that in most cases, novelty and fashion will be sufficient properties of a plant to find its way into the favor of the ornamental plant culturist. The creation of new varieties of ornamental plants should therefore be an important phase of the breeder's work.

The improvement or rather the conversion of common uncultivated plants into ornamentals, like the cultivation of wild plants of beauty, is important in itself. However, this is something that involves fashion and contempt for familiarity. A plant may be very beautiful but because it is not the fashion to use it as an ornamental or because it is very common, it is not cultivated as such. The breeder in this case may have to set the fashion himself. If he considers the work as remotely necessary he should bear in mind that the work of gathering, testing, and dissemination, among the growers, of the ornamentals now growing wild is of as much significance and importance as the introduction of foreign ornamental plants. When a foreigner interested in ornamental gardening visits a country, he anticipates seeing a garden characteristic of that country. If he goes to Japan, he desires and expects to see a Japanese garden. If he visits the Philippines he would like to see a Philippine ornamental garden and it will be not only to his disappointment but it will also speak poorly of Philippine originality if he finds the Filipino having a garden in which typical Japanese or Chinese plants predominate.

The present paper is the second attempt of the Division of Genetics of the College of Agriculture to create ameliorative interest in the most common Philippine ornamentals. The first attempt was a study of bud variation in the most common of these ornamentals, the Croton or San Francisco (*Codiaeum variegatum* (L.) Blume. The results of this study was reported by Mendiola and Magsino (1) previously.

The ornamental hibiscus is grown in the Philippines both for its ornamental value and for the medicinal use of the flower bud which is used in the treatment of boils. The hibiscus is one of the most common ornamental plants in this country and, as an ornamental, it is used in hedges extensively in the city of Manila and as individual plants throughout the Islands. In Hawaii, where apparently the greatest interest in this ornamental would be found, it is also used

as ornamental hedges or individual plants. According to Wilcox and Holt (2) whose paper has been cited somewhat freely in this work, there was formed in Hawaii, at one time, a Hibiscus Society and prizes tending to stimulate interest in the plant were offered. It is very probable that the richest collections of hibiscus varieties may be found in the Hawaiian Islands and it is a fact that many of the new varieties now growing in the Philippines are directly or indirectly of Hawaiian parentage.

Species and Varieties

In the Philippines.—Excluding the varieties which were introduced into the Philippines in 1920 and earlier and which at present are still being propagated in the College of Agriculture, there are, in the Philippines not more than three species and twelve forms or varieties of ornamental hibiscus. Of these probably not more than three are of very early introduction. These species are *Hibiscus rosa-sinensis* L., *H. schizopetalus* Hook. and *H. mutabilis* L. The first is the most common and widely found. Following is the description of these species and varieties. In the description of the varieties the locality mentioned is that in which the specimen described was found. It does not mean, however, that the variety is found only in that specific place.

Hibiscus rosa-sinensis. Gumamela or Gomamela. A shrub, plant dwarfish or one-third meter or less to three or more meters high, branches absent or are in profusion, generally vigorous; leaves smooth to rough, of various shapes, pale green to very dark green, margin may be entire or serrated or lobed or parted, 3.0 to 8.0 cm. broad and 4.0 to 17.0 cm. long, with a petiole 0.9 cm. to 4.0 cm. long, flowers axiliary, 6.0 cm to 12 cm. long; corolla 7.0 cm. to 15.0 cm. wide, varies in color, various degrees of red, white, yellow, salmon and others, one-half of back different in color; petals short to long, narrow to very broad; staminal column usually longer than the corolla; anthers and stigmas may or may not have the same color as the corolla; bracts almost absent to very conspicuous; varies as to self-fertility. Flowers all the year round and best during and immediately after the rainy months.

The following varieties may differ from one another in various respects besides in the color of the flower:

No. 1.—Flower, red with single corolla, very common all over the Islands.

No. 2.—Flower, red with double corolla, found in Los Baños.

No. 3.—Flower, white with single corolla, found in Lilio, Laguna.

No. 4.—Flower, pink with single corolla. Sometimes called Gumamela Loca.

No. 5.—Flower, yellowish with single corolla, Silang, Cavite.

No. 6.—Flower, red with multiple equally sized corolla, Silang, Cavite.

No. 7.—Flower, red with multiple corolla, inside corolla smaller, found in Rizal and Laguna Provinces.

No. 8.—Flower, pink with multiple corolla.

No. 9.—Flower, light blue, single, reported in Baguio, Benguet, and Majayjay, Laguna Province.

No. 10.—Flower, with multiple corolla, red at noon, otherwise rosy white in color, very similar to *H. mutabilis* but smaller. Found very common in Pagsanjan and Sta. Cruz, Laguna.

No. 11.—Flower, rosy white, with red eye, single corolla, medium in size. Found in barrio between San Pablo and Calawang, Laguna.

No. 12—Flower, double, white. Silang, Cavite.

H. schizopetalus. Gumamela de Araña or Araña. A shrub, several meters high, branches moderately, branches long and drooping, fairly vigorous, bark gray, petiole and side of twigs toward the plant reddish; leaves oblong-ovate or elliptic-ovate, acuminate, dentate, 4.0 cm. to 8.0 cm. long, about 3.5 cm. broad with 1.0 cm. petiole; surface smooth, dark green, thick; flowers axiliary, solitary, about 9.0 cm. long, pendulous, with long peduncle; corolla about 6.0 cm. wide, almost all red or with white linings; petals recurved, end split into lobes, or also into laciniae; staminal column about 9.0 cm. long, usually pale pink; stigmas scarlet red; anthers brownish, bracts not conspicuous; flowers all the year, hardly self-fertile.

Variety No. 1.—Flower, pale scarlet red, petals split into shallow lobes.

Variety No. 2.—Flower, red and yellowish white, petals often split into numerous slender lobes and laciniae.

H. mutabilis. Amapola or Mapola. A tall shrub, about 3 meters high, branches moderately; bark gray; leaves broadly ovate to orbicular ovate, lobed, crenate; corolla single or double, flower bigger than that of any other ornamental hibiscus, pale pink or white, crimsons at midday and for this reason it is also called the "Flor de las Doce" which means twelve o'clock flower; flowers most of the year.

Hibiscus tiliaceus L., Balibago, which is found in the Philippines and reported as an ornamental hibiscus of Hawaii is not used as an ornamental here.

New introduced varieties.—On May 10, 1920, the College of Agriculture received bud sticks of 42 or more supposedly different varieties of hibiscus from Hawaii and they were grafted on several of the native varieties. Red, pink, white, and yellow colors of flowers are represented in the introduction. A number of the grafts failed but a good number succeeded in growing and they will furnish, as they have already furnished, valuable materials in hisbiscus breeding as well as become sources of materials in varietal introduction into different parts and gardens of the Philippines in the future, enriching in this way the old very limited collection. The introductions were numbered 12394, 12395, etc., to 12437 in the Agronomy Accession Book and may in the future be referred to by these numbers. There had also been other attempts at similar introduction before 1920.

Species and varieties reported in Hawaii.—Wilcox and Holt (1913) reported the following:

H. arnottianus, native, flowers white; *H. weimeae* native, flowers pure white; *H. kokio* native, red; *H. kahilii* native, red; *H. brackenridgei* native, sulphur yellow; *H. youngianus*, native; *H. tiliaceus* native; *H. rosa-sinensis* introduced; *H. schizopetalus* and *H. mutabilis*, also introduced.

All the native white, except *H. weimeae* are said to be cross-fertile with other varieties. *H. brackenridgei*, *H. youngianus* and *H. tiliaceus* do not cross with other flowers. The three introduced species named have been used in Hawaii in extensive hybridization.

VARIABILITY IN THE HIBISCUS

In color of the flower.—Majority of the varieties known are pink, or diluted crimson. Many varieties are scarlet pink. There are various shades and combinations of crimson and scarlet, tinged in many cases with yellow or orange. The "eye" in many varieties is blackish crimson. By "eye" of hibiscus flower is meant in this case the central visible area of the flower, formed by the central inside portions of the petals. In some varieties the yellow color so predominates that, viewed a few feet off the flower, this appears practically yellow. The veins, however, are pinkish. Instead of yellow, the color may be salmon in other cases. A few varieties are white, either pure or with colored veins or with crimson eyes. One blue variety has been reported in the Philippines, but this report has not yet been confirmed. It should be borne in mind that wilted or bruised flowers of the red varieties show a bluish tinge.

Shape of flower.—Flowers may be of either of three shapes. In one, the petals are more or less recurved and the edges of the petals are wavy and scalloped. An illustration of this shape is that of *H. schizopetalus*, or the Araña variety. The recurving, in other varieties, may begin from the base of the petals. This is the second shape. A third shape, which is the most common, is that of a funnel. This form remains in many varieties until wilting time; in others, in the first part of the day they are produced.

The petals vary in form, from linear or very narrow to decidedly broad; or from about a little over a centimeter to about seven centimeters in width and two and one-half to about twelve centimeters in length; some are straight while others are curved.

Time and duration of opening.—The hibiscus flowers nearly all the year, especially during and after the rainy season. Most varieties open in the early

morning and remain open for only a day. Others open at about 9:00 o'clock in the morning. *H. brackenridgei* opens only late in the afternoon. In some varieties, the flowers may remain open for two or even three days.

Habit of growth.—Hibiscus varieties vary from small dwarf shrubs to trees ten or more meters tall; from those which are thickly tufted and shrubby to those showing whip-like growth with few or no lateral branches. In some varieties the foliage is dense and the leaves are found throughout the wood, others have naked wood and produce leaves only near the tips of the twigs.

Leaf characteristics.—The leaf surface may be rough, or smooth, hairy or pubescent, dull or shiny. Some varieties have linear leaves, others lanceolate and ovate, while still others, orbicular. The margin varies from entire, through various degrees of crenation, serration and dentation, to deeply incised, three-lobed or completely three-divided forms.

Other characteristics.—The outside part of the petals, as these overlap in the bud stage, is different in color from the other part. The color is generally white, but it may also be yellow in other cases.

The eye varies in width from more than a centimeter to about eight centimeters, and has a darker color than the rest of the petal. The deep color of the eye may extend farther out on the petals into the veins, leaving lighter areas between the veins. The veins may be pink or white. When white, the throat is ordinarily white also. The staminal column varies in length from about four centimeters to about 15 centimeters. The column may be smooth in some cases, or pubescent in others. The filaments may be absent in other varieties while in others they may be more than 2 centimeters long. The stigmas vary in shape. Some are appressed together, others are divergent or at right or reflex angles with the column. The column may be stiff in some varieties, or pendulous in others.

METHODS OF IMPROVEMENT

These are (*a*) by introduction of new species and varieties, (*b*) by artificial hybridization, (*c*) by bud selection, and (*d*) production and selection of new seedling varieties.

Introduction of new species and varieties.—An example of this work is found in Hawaii. It is said that from all over the world varieties were collected and assembled in this country where they have furnished rich materials for hybridization and dissemination. Foreign varieties are necessary to the breeder specially in hybridization work. Before and since the American occupation of the Islands in 1900 there have been probably scattered attempts at introduction of foreign varieties into the Philippines by private enterprise. The College of Agriculture began the collection of different varieties found in the Philippines in 1910. In 1913 the first importation of foreign varieties was made when Professor Baker brought with him from Hawaii several varieties from that country. The latest and bigger importation was in 1920 also from Hawaii and made by Professor Higgins. As a result of these importations and the attempt to assemble native grown forms and the breeding work under report, there is now in the College cultures easily the richest collection of ornamental hibiscus in the Philippines. This collection is bound to give greater variety to the forms grown by private individuals.

Artificial hybridization.—The ornamental hibiscus is grown principally for its flower. The flower exists in many colors and color combinations, and this fact should make it easy for the breeder to get desired colors and combinations which it is possible to create. If a pure blue, pure green and pure black hibiscus could be produced, these should be of enormous value to the present collections of hibiscus known.

The technique of hybridizing hibiscus is very simple and easy because the flower and its parts are large and easy to handle. While the hibiscus flower is always perfect, it is known that some varieties are not or are difficultly self-fertile. Where this is known there is no necessity of emasculation. Emasculation is done the night before the morning the flower is expected to open, and then bagged, as usual. Pollination is done in the following day, and may be done from morning till noon, after which process the bag is restored for two or three days until the stigmas have wilted. It is advised by hibiscus breeders to use the stigmas and pollen when dry in crossing, otherwise, fertilization may not take place. In a few varieties, as the Nuuanu white of Hawaii, there is need of moistening the stigmas to allow the germination of the pollen.

Bud selection.—Various cases of bud variation in hibiscus have been reported by reliable persons. One case consists in a branch of a pink variety, producing white flowers. Another was a branch of a red variety producing pink flowers. In this College, several cases of bud variations, involving a change in leaf shape, have been observed on seedling varieties. A more common change is from broad or entire shape to that in which the leaves are deeply lobed and narrow. It is impossible to tell at present if these changes are mutations. The bud variations are produced invariably at the base of the plant. It is only to be expected that so big a change as these would be hereditary and their propagation will constitute a method of hibiscus breeding. An interesting hybrid was reported in Hawaii in which each twig was found different from any other.

Production and selection of new seedling varieties.—Hibiscus is more or less subject to natural crossing. Since it has been propagated almost exclusively by cuttings, it is only to be expected that there will be sufficient variability among seedlings to afford selection of new varieties. The work of producing seedling varieties in this College tends to support this supposition. By growing selfed seeds of one native variety, different seedling varieties have been produced. Variation is found either in the color and size of the flower, in the shape and size of the leaves, or in the habit of growth of the plant. In the light of these results growers of native hibiscus could produce new varieties of this plant if they could obtain seeds from their plants and grow them.

Some varieties produce many seeds while others produce only few seeds. A fruit may have from 5 to 30 seeds located in five chambers. It takes about a month for a fruit to mature from the flower stage. The seed is germinated like ordinary garden seeds. No special technique is required in germination. Seeds may germinate in 10 to 30 days.

The seedlings may be potted first before transplanting or may be transplanted direct to the garden.

Hibiscus seedlings began to flower in this College in from seven to nine months from the time the seeds were sown in seed boxes. These seedlings were

potted first before transplanting. It is believed that with better care, they would have flowered earlier. In Hawaii, the time required is from nine to twelve months.

PROPAGATION

By seed.—Unless it is desired to obtain new varieties of hibiscus, it is not advisable to propagate it by seed, although, as has been mentioned already, many varieties seed freely and the seeds have been used to produce hibiscus plants. To perpetuate varietal characters, propagation should be by vegetative means.

By cuttings.—This is the only method used generally in the Philippines. It is said that the best cutting to use is from wood one and one-half centimeters in diameter and fairly well matured. The tendency in the Philippines has been to use wood of smaller diameter. It is advised to make the cuttings about fifteen centimeters long and to root them in sand about one decimeter deep. If it is necessary to handle hundreds of cuttings, these may be tied in bundles of 100 for convenience. Cuttings prepared and planted in sand properly root in about a month. The rooted cuttings are transplanted, either into pots or into the garden. After rooting and transplanting, cuttings may flower in about six months.

By grafting.—This method is not at present adapted to common use by the ordinary person, but it is the quickest method in obtaining flowers from desirable plants.

Compared with budding, grafting is more desirable in that it gives a more symmetrical and profuse branching. Grafted scions bear flowers in about six months.

By budding.—Hibiscus may also be budded.

Results of hibiscus breeding in Hawaii.—In Hawaii, a number of new varieties have been produced by hybridization. These are described by Wilcox and Holt in a bulletin already referred to. A number of colored illustrations of old and new hybrid varieties were published in that bulletin and in an issue of the Mid-Pacific Magazine (**13:** (No. 2), February, 1917).

New varieties produced in the College of Agriculture.—Some one hundred new varieties of ornamental hibiscus have been produced in the College of Agriculture both by hybridization and selfing. Most of these are in the first seedling generation while a number are already in the second generation. These varieties have already flowered and among them various degrees of pink, red, white, yellow and salmon are represented. Several of them have produced bud modifications consisting of branches of different shaped leaves at the base of the stem. Requests for cuttings of some of the most beautiful seedling varieties have been received from several sources. At the request of the Bureau of Agriculture, cuttings of several desirable varieties were sent to several of its experiment stations from which it is expected that these new varieties will gradually find their way into the Philippine ornamental gardens and yards. Several private individuals who have seen these varieties in the Plant Breeding Nursery have also obtained several cuttings of such varieties as have pleased their eyes. Among such individuals are two from Pila, Laguna, who very kindly gave the Division cuttings of their varieties which are not found in the Division's collection.

At about the age of two years, these College hibiscus seedlings were studied with a view to determining their suitability as a Philippine ornamental and va-

rious adaptabilities as such. These seedlings were allowed to grow up to the time this study was made without pruning inasmuch as in the Philippines ornamental hibiscus is, and will be for some time to come, grown without pruning, and it was thought more proper to study these new varieties under conditions in which they are expected to be grown. Undoubtedly it will be necessary also, as a provision for special uses, to study subsequently how these varieties will respond to pruning.

Three characteristics are of outstanding importance in their adaptability as ornamentals. These are the height, the branching habit, and the appearance of the flower.

Regarding height, these seedlings may be grouped into tall, medium, and dwarf. (Plate I.) The first two groups are quite adapted for ornamental hedges and for individual plants behind fences. Possessing the height that they have, they could peep over the fences which are common in the native yards and thus could be exposed to the gaze of passers-by. The dwarf varieties are adopted for pot ornamentals. This type is something new in Philippine hibiscus growing as the old varieties are of the tall group. The result of an observation on a number of F_2 seedlings would tend to indicate that dwarfness is a recessive character.

In branching habit, the varieties vary from that type in which the branches are almost parallel to the main stem to that in which the branches are at right angles. In between these two types, are various forms in which the branches are spreading or drooping or lie in both and other positions. (Plate I.) The number of branches varies from practically none in those types which exhibit whip-like growth to numerous. It is very likely that non-branching habit is a recessive character.

The flower as well as other characteristics of the different varieties may be learned from the following descriptions. The seedlings are grouped as to parentage. By observing the variability existing among the offspring of each parent and whether the seeds from which these seedlings were artificial hybrids or not, an insight may be obtained as to the purity or homozygosity of the parent and as to what variability may be expected in similar work. It should be mentioned that for purposes of Mendelian study of heredity in hibiscus, the hybrids obtained in this work and described below are not suitable materials for study inasmuch as their parents are of unknown purity. In color descriptions, Ridgway's (3) book was used as reference.

PARENT: PINK. SEEDLINGS:

PINK-1.

Plant 85.0 cm high, branches lightly, not vigorous; leaves rough, round ovate, 3.5 cm. x 4.2 cm, with 0.9 cm. petiole; corolla 10.0 cm. wide, petals narrow, recurving, one-half of each petal shrimp pink, one half rose shade; staminal column, 5.0 cm. long, white; stigmas scarlet; anthers yellowish; corolla throat at a diameter of 2.0 cm. distinct white; bracts 6, small, regularly set; susceptible to insect attack.

Pink-2 and Pink-3 are similar to Pink-1 in flower form and coloration, except that the former have their stigmas orange in color.

PINK-12.

Plant 70.0 cm. high, does not branch, exhibiting whip-growth habit, fairly vigorous, leaves smooth, ovate to cordate, 6.0 cm. x 7.3 cm. with 2.5 cm. petiole; corolla 10.0 cm. wide, petals straight, mustard yellow, base of petals with brownish red streaks; staminal column 7.2 cm. long, yellow; stigmas scarlet; anthers yellow; bracts 8, small and spreading.

PINK-14

Plant 74.0 cm. high, branches moderately, fairly vigorous; leaves rough, ovate to cordate in shape, 6.5 cm. x 4.2 cm. with 3.0 cm. petiole; corolla 6.5 cm. wide, gray-violet with pink tinge; staminal column 3.8 cm. long, whitish; stigmas red; anthers yellowish brown; eye lined with pink; bracts 7, spreading; seeding freely.

PINK-16.

Plant 63.0 cm. high, branches little, fairly vigorous; leaves fairly rough, elliptical, 2.2 cm. x 4.0 cm., with 2.0 cm. petiole; corolla 11.3 cm. wide, whitish pink; staminal column 4.5 cm. long, whitish yellow; stigmas scarlet red; anthers scarlet red; eye white, base of petal with pink rays; bracts 6, spreading.

PINK-17.

Plant 90.0 cm. high, branches profusely, fairly vigorous; leaves rough, ovate, 4.5 cm. x 6.5 cm. with 4.0 cm. petiole; corolla 11.5 cm. wide, corinthian pink with pink rays; staminal column 6.2 cm. long, white; stigmas orange chrome; anthers light orange yellow; eye with pink rays; bracts 7, spreading; self seeding.

Seedlings similar to Pink-17 in flower characteristics are Pink-13, Pink-15 and 24 Pink 12396-104.

PINK-18.

Flower characteristics very similar to Unknown-11.

PARENTS: DEEP PINK x BROWN. SEEDLINGS:

(DEEP PINK x BROWN) F_1-1.

Plant 150.0 cm. high, branches profusely, medium in vigour; leaves smooth, ovate to cordate, 4.0 cm. x 6.5 cm. with 2.0 cm. petiole; corolla 11.0 cm. wide, petals flat, pale pink with rose veins; staminal column 4.5 cm. long, yellowish; stigmas scarlet red; anthers yellow, corolla throat at a diameter of 2.5 cm. white; bracts 8, long and spreading. Susceptible to insect attacks.

(DEEP PINK x BROWN) F_1-2.

Plant 145.0 cm. high, branches moderately, vigorous; leaves rough, ovate to cordate, 3.5 cm. x 6.0 cm. with 1.5 cm. petiole; corolla 11.5 cm. wide, petals recurved, salmon orange with orange yellow streaks; one-half of back orange yellow; staminal column 6.0 cm. long, orange yellow; stigmas scarlet red; anthers light salmon orange; eye 2.2 cm. wide, light orange yellow; bracts 8, long loosely spreading; self-seeding to a little extent.

(DEEP PINK x BROWN) F_1-3.

Plant 200.0 cm high, branches lightly, obliquely, vigorous; leaves rough, ovate, serrated, 4.5 cm. x 6.2 cm. with 1.7 cm. petiole; corolla 13.0 cm. wide, light pink with distinct veins; staminal column 8.5 cm. long, yellowish white; stigmas orange, anthers yellow; eye 2.0 cm. diameter, white; bracts 8, long, spreading.

(DEEP PINK x BROWN) F_1-4.

Plant 120.0 cm. high, branches moderately, close habit of branching, fairly vigorous; leaves rough, ovate to cordate, 4.5 cm. x 7.0 cm. with 2.5 cm. petiole; corolla 12.5 cm. wide, petals slightly recurving, white, edge of base of petals pink; staminal column 6.5 cm. long, white; stigmas orange chrome; anthers brownish; throat of corolla white with pink rays; bracts 8.

(DEEP PINK x BROWN) F_1-5.

Plant 150.0 cm. high, branches lightly, vigorous; leaves rough, ovate, 6.5 cm. x 4.2. cm. with 1.5 cm. petiole; corolla 12.5 cm. wide, white; staminal column 8.0 cm. long, yellowish white; stigmas orange; anthers yellow; bracts 9, spreading; blooms in the afternoon.

(DEEP PINK x BROWN) F_1-6

Plant 140 cm. high; branches fairly; very vigorous; leaves rough, ovate 5 cm. x 6.5 cm. with 1.8 cm. petiole; corolla 10.5 cm. wide; petals slightly recurving, scarlet with light orange yellow veins; staminal column 6.0 cm. yellowish brown; stigmas scarlet; anthers brownish; corolla throat at diameter of 2.2 cm. pale brownish shade; bracts 8, regularly and closely set. One-half back of corolla, cadmium yellow badged. Flowers at long intervals of time.

(DEEP PINK x BROWN) F_1-7.

Similar to (Deep Pink x Brown) F_1-3.

(DEEP PINK x BROWN) F_1-8.

Plant 89.0 cm. high, branches moderately, fairly vigorous; leaves rather rough, ovate, 5.5 cm. x 6.5 cm. with 3.0 cm. petiole; corolla 9.0 cm. wide, daphne pink with white veins; staminal column 4.8 cm. long, pale pink; stigmas scarlet red; anthers yellow; bracts 9, closely arranged.

(DEEP PINK x BROWN) F_1-9.

Plant somewhat dwarfish, 80.0 cm. high branches moderately, fairly vigorous; leaves rough, ovate to cordate, 4.0 cm. x 6.0 cm. with 1.8 cm petiole; corolla 10.5 cm wide, petals flat, eosine pink with pale violet shade; staminal column 5.0 cm. long, rose; stigmas carmine, anthers yellowish; base of petals deep pink; bracts 8, spreading. Blooms at rather long intervals of time.

(DEEP PINK x BROWN) F_1-10.

Plant 105.0 cm. high, branches sparsely, fairly vigorous; leaves rough, ovate, 5.0 cm. x 7.5 cm. with 3.5 cm. petiole; corolla 10.4 cm. wide salmon orange with yellow linings; staminal column 6.5 cm. long, orange-yellow, stigmas scarlet red; anthers pale orange yellow; eye 2.0 cm. diameter, carmine; bracts 8, long, spreading.

PARENTS: NATIVE RED x HAWAIIAN SALMON. SEEDLINGS:

(NATIVE RED x HAWAIIAN SALMON) F_1-1.

Plant 210.0 cm. high, branches very profusely, very vigorous; leaves somewhat rough, ovate to cordate, 4.0 cm. x 5.2 cm. with 1.3 cm. petiole; corolla 10.0 cm. wide, solid rose red; staminal column 7.0 cm. long, red; stigmas scarlet; anthers brownish; eye, carmine; bracts 8, broad, close to peduncle; susceptible to insect attack.

(NATIVE RED x HAWAIIAN SALMON) F_1-2.

Plant 190.0 cm. high, branches profusely, vigorous, leaves rather rough, ovate to elliptical, 7.0 cm. x 4.5 cm. with 2.0 cm. petiole; corolla 11.0 cm. wide, flat, slightly recurving, rosy with eosine pink veins; staminal column 6.0 cm. long, pale yellow with carmine base; stigmas scarlet red; anthers pink; eye 3.0 cm. diameter, carmine; bracts 8, short, spreading.

(NATIVE RED x HAWAIIAN SALMON) F_1-4.

Plant 90.0 cm. high, branches moderately, fairly vigorous; leaves rough, cordate, 4.0 cm x 4.7 cm with 1.5 cm. petiole; corolla 10.3 cm. long, salmon orange with one-half of back maize-yellow; staminal column 5.8 cm. long, rose pink; stigmas carmine; anthers yellow; eye 3.0 cm. diameter, persian lilac; bracts 9, irregularly but closely set. Seeding freely.

PARENTS: HAWAIIAN SALMON x NATIVE RED. SEEDLING:

(HAWAIIAN SALMON x NATIVE RED) F_1-1.

Plant 200.0 cm. high, branches almost in a horizontal position, vigorous; leaves smooth, ovate, others three-parted, 2.5 cm. x 6.0 cm. with 1.3 cm. petiole; corolla 11.5 cm. wide; petals narrow, recurving, whitish pink with pale violet shade; staminal column 5.5 cm. long, pale pink; stigmas scarlet red; anthers brownish; eye carmine; bracts 6, long, spreading. Flowers open in the afternoon.

PARENTS: HAWAIIAN PINK x HAWAIIAN SALMON. SEEDLINGS:

(HAWAIIAN PINK x HAWAIIAN SALMON) F_1-3.

Plant 58.0 cm. high, branches moderately, fairly vigorous; leaves somewhat rough, ovate, 6.0 cm x 8.0 cm. with 3.4 cm. petiole; corolla 7.5 cm. wide, red salmon with yellow linings; staminal column 5.4 cm. long, yellowish brown, stigmas orange; anthers pale yellow; throat of corolla with yellow rays; bracts 6, straight, adhering; does not seed freely.

(HAWAIIAN PINK x HAWAIIAN SALMON) F_1-4

Plant 123.0 cm. high, branches fairly, vigorous leaves rough, ovate to cordate, 4.0 cm x 5.5 cm. with 2.0 cm. petiole; corolla 11.5 cm. wide; deep pink with white veins; staminal column 6.3 cm., whitish,; stigmas crimson; anthers yellowish; base of petals at a diameter of 2.0 cm., distinct white; bracts 7, long regularly set. Seeding very freely.

PARENT: PINK 12396-104. SEEDLINGS:

11 PINK 12396-104.

Plant 80.0 cm. high, branches lightly, fairly vigorous; leaves rough, elliptical-ovate, 2.5 cm. x 4.0 cm. with 12. cm. petiole; corolla 7.0 cm. wide, light rose with pink veins; staminal column 5.0 cm. long, yellowish; stigmas crimson; anthers yellow; bracts 8, long, closely set.

13 PINK 12396-104.

Plant 100.0 cm. high, branches moderately, fairly vigorous; leaves smooth, elongated-ovate, 3.5 cm. x 6.0 cm. with 3.0 cm. petiole; corolla 8.0 cm. wide, rose with pink rays, one-half of back yellow; staminal column 6.0 cm. long, yellowish; stigmas crimson; anthers yellow; eye 1.5 cm. diameter, with throat of corolla, white; very susceptible to insect attacks.

17 PINK 12396-104.

Plant 72.0 cm. high, branching moderately, fairly vigorous; leaves elliptical ovate 3.4 cm. x 5.5 cm. with 2.5 cm. petiole; corolla 11.5 cm. wide, eosine pink with white veins; staminal column, 4.5 cm. long, yellowish white; stigmas scarlet; anthers yellowish; corolla throat at diameter of 2.0 cm. pink and white mixed; bracts 6, long, spreading. Somewhat free seeding.

19 Pink 12396-104.

Plant 118.0 cm. high, branches moderately, fairly vigorous; leaves rather smooth, round ovate, 4.5 cm. x 6.1 cm. with 2.5 cm. petiole, corolla 9.0 cm. wide, light orange yellow with reddish veins; staminal column 5.5 cm. long, yellowish; stigmas scarlet red; anthers brownish; corolla throat at a diameter of 1.8 cm. deep chrome shade; bracts 7, regularly set; flowers open at rather long intervals of time.

20 PINK 12396-104.

Plant 60.0 cm. high, branches moderately, fairly vigorous; leaves rough, roundish ovate to cordate, 3.8 cm. x 5.2 cm. with 1.1 cm. petiole; corolla 9.2 cm. wide, gray violet with pink rays, one half of back yellowish; petals straight; staminal column 6.5 cm. long, whitish; stigmas orange red; anthers yellowish brown; base of petals with pink streaks; bracts 7, short, spreading.

21 PINK 12396-104.

Plant 66.0 cm. high, branches moderately, fairly vigorous; leaves fairly smooth, oblong-ovate, 6.5 cm. x 3.5 cm. with 2.5 cm. petiole; corolla 10.5 cm. wide, petals recurving, pale pink with pink linings, one-half of back of corolla white; staminal column 4.5 cm. long, whitish; stigmas reddish yellow; anthers pale yellow; base of petals pink; bracts 6, spreading; not self-seeding.

22 PINK 12396-104.

Plant 60.0 cm. high, branches moderately, fairly vigorous; leaves smooth, ovate, 4.2 cm. x 6.0 cm. with 1.8 cm. petiole; corolla 9.2 cm. wide, light violet pink with one-half of back yellowish, with pink linings, staminal column 5.0 cm. long, whitish yellow; stigmas scarlet; anthers yellow; eye 1.4 cm. diameter, white; bracts 7, short, spreading; seeds freely.

23 PINK 12396-104.

Plant 90.0 cm. high, branches very lightly, fairly vigorous; leaves smooth, elliptical ovate 3.5 cm. x 5.5 cm. with 2.0 cm. petiole. Corolla 9.0 cm. wide, La France pink with white veins; staminal column 4.8 cm. long, whitish; stigmas scarlet; anthers yellowish; corolla throat at diameter of 2.0 cm. white; bracts 8, irregularly placed, spreading. Leaves very few, confined to tip of branches.

24 PINK 12396-104.

Very similar in flower characteristics to Pink-17.

PARENTS: YELLOW x PINK. SEEDLING:

(YELLOW x PINK) F_1-1.

Plant 110.0 cm. high, branches moderately, fairly vigorous; leaves smooth, ovate, 2.5 cm. x 5.6 cm. with 1.0 cm. petiole; corolla 9.5 cm. wide, pink, edge of base of petals white, one-half of back of corolla white; staminal column 5.5 cm. long, light purple; stigmas scarlet red; anthers pink; bracts 6, spreading.

PARENTS: PINK x ARAÑA. SEEDLING:

(PINK x ARAÑA) F_1-4.

Plant 131.0 cm. high, branches moderately, vigorous; leaves smooth, elliptical ovate, 4.0 cm. x 5.2 cm. with 1.5 cm. petiole; corolla 10.0 cm wide, one-half of back yellow, petals slightly recurving, rose pink with rose veins; staminal column 5.0 cm long, whitish; stigmas scarlet; anthers yellowish; corolla throat at diameter 1.8 cm. white; bracts 7, regularly placed.

PARENTS: ARAÑA x PINK. SEEDLINGS:

(ARAÑA x PINK) F_1-1.

Plant 98.0 cm. high, non-branching, fairly vigorous; leaves smooth, round ovate, 3.5 cm. x 4.8 cm. with 1.2 cm. petiole; corolla 11.0 cm. wide, petals slightly recurving, flame scarlet with light salmon-orange veins; staminal column 5.5 cm. long, yellow; stigmas, scarlet red; anthers yellow; eye at a diameter of 2.0 cm. yellow and red rays; bracts 8, medium, regularly placed.

(ARAÑA x PINK) F_1-3.

Plant 115.0 cm. high, branches moderately, twigs in horizontal position, fairly vigorous; leaves smooth, round-ovate, 6.0 cm. x 6.7 cm. with 2.5 cm. petiole; corolla 10.5 cm. wide, deep rose pink with white veins; staminal column 5.5 cm. long, yellowish pink; flower throat with some pink rays; bracts, 8, regularly set. Seeding freely.

Seedlings similar to this in flower are (Ping x Araña) F_1-1 and (Pink x Araña) F_1-3.

PARENTS: HAWAIIAN PINK x NATIVE RED. SEEDLINGS:

(HAWAIIAN PINK x NATIVE RED) F_1-1.

Plant 208.0 cm. hgih, branches very heavily, very vigorous; leaves rough, ovate, others three-parted; 3.5 cm. x 6.2 cm. with 1.0 cm. petiole; corolla 12.5 cm. wide, petals slightly recurving; staminal column 7.0 cm. long, pink; stigmas, carmine; anthers brownish; eye carmine, with a diameter of 3.0 cm.; bracts 7, regularly placed; one-half of back of corolla white; seeds freely.

(HAWAIIAN PINK x NATIVE RED) F_1-2.

Plant 214.0 cm. high, branches lie horizontally, very vigorous; leaves smooth, ovate, others three-parted, 4.0 cm. x 5.5 cm. with 1.4 cm. petiole; corolla 11.0 cm. wide, one-half of back white, petals narrow, straight, eosine pink with begonia rose veins; staminal column 6.0 cm. long, pale pink; stigmas carmine; anthers brownish, eye scarlet, 1.5 cm. diameter; bracts 6, spreading; seeding freely.

PARENT: UNKNOWN. SEEDLINGS:

UNKNOWN-1.

Plant 140.0 cm. high, branches moderately, branches closely arranged, vigorous; leaves smooth, ovate to elliptical, 4.8 cm. x 6.0 cm. with 1.5 cm. petiole; corolla 11.0 cm. wide, flat, slightly recurving, begonia rose with reddish rays and veins with one-half of back maize yellow; staminal column 4.5 cm. long, rose; stigmas scarlet red; anthers pink; eye, 2.0 cm. diameter, scarlet; bracts 7, long, spreading. Seeding very freely.

UNKNOWN-3.

Plant 160.0 cm. high, branches profusely, very vigorous; leaves smooth, cordate to ovate, 5.0 cm. x 7.2 cm. with 3.2 cm. petiole; corolla 11.0 cm. wide, petals recurving, Rosolane pink with thulite pink veins; staminal column 6.0 cm. long, white; stigmas deep red; anthers yellow with pink filament; eye 2.5 cm. diameter, crimson; bracts 7, closely set; flower bud pink. Naturally self-seeding.

UNKNOWN-4.

Same as Unknown-3.

UNKNOWN-6.

Plant 200.0 cm. high, branches heavily, very vigorous; leaves smooth, cordate, three-parted, 6.0 cm. x 9.5 cm. with 5.0 cm. petiole; corolla 8.0 cm. wide, solid pink; staminal column 6.5 cm. long, pink; stigmas crimson red; bracts 7, long, spreading; petals do not spread evenly.

UNKNOWN-7.

Plant 100.0 cm. high, branches heavily, very vigorous; leaves smooth, ovate to cordate, serrated, 7.5 cm. x 11.5 cm. with 6.0 cm. petiole, corolla 13.0 cm. wide, petals recurving, pink with dark pink veins, and one-half of back of corolla white; staminal column 7.0 cm. long, pink red; stigmas crimson red; anthers yellow, filament red; eye 4.0 cm. diameter, crimson red; bracts 8, closely set; naturally self-seeding. Other Unknown seedlings very much like Unknown-7 are: Unknown-2 (except this has narrower corolla), Unknown-5 is very similar to Unknown-7 in flower characteristics.

UNKNOWN-8.

Plant 98.0 cm. high, branches profusely, fairly vigorous; leaves somewhat smooth, ovate, 5.5 cm. x 7.8 cm. with 2.5 cm. petiole; corolla 12.0 cm. wide, petals somewhat recurving, pink with white veins; staminal column 6.2 cm. long, whitish yellow; stigmas crimson red; anthers yellowish brown; throat of corolla 3.0 cm. diameter, white; bracts 7, spreading, irregularly set; naturally self-seeding.

UNKNOWN-10.

Plant 158.0 cm. high, branches moderately fairly vigorous; leaves, rough, elongated-ovate, 4.0 cm. x 7.5 cm. with 2.5 cm. petiole; corolla 9.5 cm. wide, Begonia rose, distinct white veins one-half of back blotched white; staminal column 7.5 cm. long, yellowish; stigmas, scarlet; base of petals, with crimson veins at edge; bracts 6, regularly set.

UNKNOWN-11.

Plant 114.0 cm. high; branches moderately, vigorous; leaves smooth; ovate to cordate, 4.7 cm. x 5.6 cm with 1.2 cm. petiole; corolla 7.0 cm. wide, cadmium orange with distinct yellow veins; staminal column 4.4 cm. long, yellowish; stigmas scarlet; anthers brownish; corolla throat at 1.8 cm. diameter light orange yellow; bracts 7, long, close to peduncle. Susceptible to insect attack.

UNKNOWN-12.

Plant dwarfish, 14.0 cm. high, branches heavily, vigorous; leaves smooth, cordate, 5.1 cm. x 7.2 cm. with 1.3 cm. petiole; corolla 10.5 cm. wide, petals slightly recurving, solid nopal red, with one-half of back of corolla salmon orange; staminal column 5.2 cm. long, pale scarlet; stigmas carmine; anthers carmine, bracts 8, spreading, medium in length.

PARENT: NATIVE RED. SEEDLING:

NATIVE RED-1.

Plant 140.0 cm high, branches profusely, vigorous; leaves smooth, elongated-ovate, three parted; with 1.5 cm. petiole; corolla 12.0 cm. wide, deep pink, one-half of back white, petals narrow; staminal column 7.0 cm. long, pink; stigmas scarlet red; anthers pink-red; eye dark crimson; bracts, 7, long, spreading.

IMPORTANT INSECT ENEMIES

Two important enemies of the seedling hibiscus reported in this paper have been discovered. These are as identified by the Entomology Department of the College of Agriculture the insects *Phenacoccus hirsutus* Green, belonging to the family Coccidae, and two species of *Nisotra*,—*Nisotra gemella* Erichs. and *Nisotra* sp. which belong to the family Chrysomelidae. These insects eat the flower buds, the open petals and the tender leaves of the plant. It is not known that the native varieties are attacked by these enemies, and some of the seedling varieties are fairly resistant to them. Wilcox and Holt made no mention of these particular pests in their work. It is very probable that these insects have contributed very largely to the causes of the failures of many of the introduced ornamental hibiscus in this College, and, in the future, are a factor to contend with in further introduction. Mr. Feliciano Reveche who made some studies of the pests declares that *Phenacoccus hirsutus* could be controlled with kerosene emulsion spray in which the constituents are in the proportion of 7.5 liters kerosene, one-fourth kilogram hard soap and 4 liters of water. Other insects were observed, some of them feeding on the leaves, but they are comparatively not serious to the growth of the plant, although the holes which are produced in the leaves give these an ugly appearance at times.

ACKNOWLEDGEMENT

The authors are greatly indebted to Mr. Juan Unite, also of the Genetics Division of the Agronomy Department, for taking care of most of the hibiscus cultures involved in this study and his contribution in the information on the different seedling varieties, and to Plant Breeding students of the year 1920-21.

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Plate I

Height types of seedlings.
Branching types of seedlings.

Figure 1

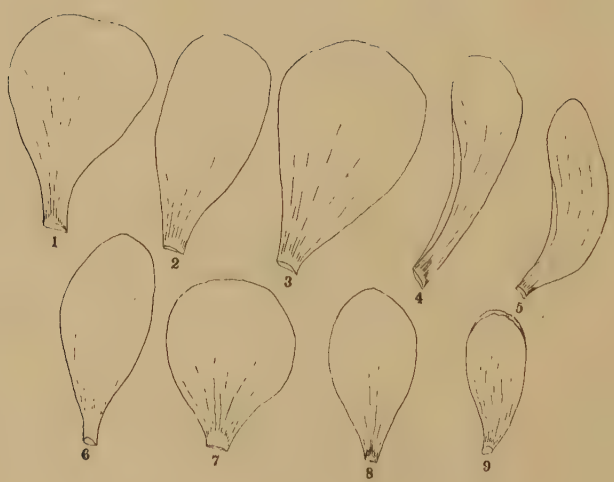

Figure 2

Plate II

FIGURE 1 (*a*) Flower bud of Gomamela, longitudinal section. (*b*) Gomamela fruit, bursting. (*c*) Longitudinal section of matured fruit, showing seed attachment.

FIGURE 2 Different shapes of petals (single corolla) as shown by the seedlings reported here.

ADDITIONAL CYANOPHORIC PLANTS OF THE MAKILING REGION[1]

By J. B. Juliano

Of the Department of Plant Physiology

The list of plants herewith presented is by no means a thorough study of all cyanophoric plants in this locality but is rather an addition to what had already been drawn up by Professor D. A. Herbert of the Department of Plant Physiology. Only grasses, weeds, as well as some ornamental and food plants were dealt with. The second modified Guignard test was employed and consisted in "the immersion of the material in sodium picrate solution to which a little chloroform had been added". Most of these tests were carried by the second year Veterinary students working under the supervision on a course of Veterinary Botany at the College of Agriculture during the month of January, 1923, of the second semester of the school year 1922-23. Some results of tests have not been included so as to avoid duplication, but all of them confirmed the findings just recently reported. However, some plants which gave negative reactions before show faint traces of prussic acid. This may be due to differences in time of the determinations and the attendant conditions surrounding the plants studied.

AMARANTHACEAE

Amaranthus viridis (Colites): Trace in root, stem, and leaves.

ARACEAE

Colocasia esculentum (Gabi): Slightly positive in root, stem, and leaves.

Xanthosoma sagittifolia: Slightly positive in tuber, leaves and petioles.

CANNACEAE

Canna speciosa: Positive in leaves, slightly positive in stem and roots.

CARICACEAE

Carica papaya (Young papaya): Slightly positive in stem and roots.

COMMELINACEAE

Commelina benghalensis (Alicbangon): Negative in root and leaf, trace in stem.

COMPOSITAE

Synedrella nodiflora: Negative in leaf, trace in roots and stems.

CYPERACEAE

Cyperus distans: Positive in root, slightly positive in stems and leaves.

CRUCIFERAE

Brassica oleracea (Cabbage): Trace in root, stem, and leaves.

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[1] Experiment Station Contribution No. 111.

EUPHORBIACEAE

Euphorbia hirta: Positive in roots, trace in stem and leaves.

Manihot utilissima (Manioc, Camoteng Kahoy): Positive in root and leaves, slightly positive in stem.

GRAMINEAE

Andropogon sorghum (Sorghum, Batad): Slightly positive in roots, stems and leaves.

Andropogon halapensis (Batad-bataran): Positive in roots, slightly positive in stems and leaves.

Bambusa blumeana (Cauayan totoo):. Trace in roots.

Panicum flavidum: Trace in root and leaves.

Paspalum conjugatum (Calupe): Positive in root, trace in stem and leaves.

LABIATAE

Leucas lavandulifolia: Positive in roots, stems, leaves, and trace in flowers.

LEGUMINOSAE

Arachis hypogea (Mani): Positive in roots, trace in stem; negative in leaves.

Canavalia ensiformis (Sword bean): Trace in roots and leaves; negative in stem.

Indigofera suffruticosa: Trace in roots, stems, leaves and fruit.

Phaseolus radiatus (Mongo): Slightly positive in roots, leaves and fruits; negative in stem.

Pisum sativum (Pea, Chicharo): Trace in root, stem, leaves and fruits.

Tephrosia candida: Trace in roots, stem, leaves and flowers.

MALVACEAE

Corchorus capsularis (Pasaó): Slightly positive in leaves, stems, roots and fruits.

MARANTACEAE

Marantus arundinacea (Sagó): Slightly positive in roots and leaves.

MYRTACEAE

Psidium guajava (Guava, bayabas): Trace in root, stem, leaves, and fruits.

OXALIDACEAE

Averrhoa bilimbi (Camias): Slightly positive in roots, stems, leaves; negative in fruit.

PORTULACACEAE

Portulaca oleracea (Golasiman): Slightly positive in roots, stems, leaves and fruits.

POLYGONACEAE

Polygonum barbatum: Slightly positive in roots, leaves, and stems.

URTICACEAE

Boehmeria nivea (China grass, Ramie): Slightly positive in root, stem and leaves.

COLLEGE AND ALUMNI NOTES

B. M. Gonzalez, '13, completed his work for the degree of Doctor of Science in November, 1922, in Johns Hopkins University. The topic of his dissertation, presented to the faculty of the School of Hygiene in Johns Hopkins University, is "The Chromosomal Localization of Five Factors Determining Duration of Life in Drosophila melanogaster". He is now travelling, with his family, in Europe, and expects to be back before classes open here in June.

Sotero F. Albano, '13, is with the Bureau of Agriculture as Fiber Inspector for the Ilocos provinces. His business address is at Vigan, Ilocos Sur. Mr. Albano was formerly an assistant in the Department of Mathematics and later in the Department of Agronomy of this College.

Gregorio Grageda, '16, is supervising teacher for Sigaboy District in Davao. He was formerly the Technical Agricultural Assistant for Sulu. This office was later abolished causing his transfer to Davao.

Domingo B. Paguirigan, '16, who was a pensionado of the Bureau of Agriculture, obtained the degree of Master of Science from Connecticut Agricultural College in 1920. He was employed in the Connecticut Agricultural Experiment Station at New Haven during the summer of 1920, and attended the Bussey Institution during the year 1920-1921. He is at present with the Bureau of Agriculture, in charge of the tobacco work of the Bureau. He is stationed mostly at the Dammao Tobacco Station, Gamu, Isabela, and part of the time in Manila, and in Pikit, Cotabato, and possibly also, at the College of Agriculture.

Leoncio Dario, '19, has been with the Bureau of Agriculture since his graduation from the College. He is at present detailed in the Manila office working in the Agronomy Section of the Plant Industry Division.

Anastacio Limbo, '20, is Acting Industrial Supervisor of fifty-nine settlement farm schools in Bukidnon. His address is Malaybalay, Bukidnon.

Antonio Derecho, '20, is now Acting Supervising Agricultural Agent of the Bureau of Agriculture. He experienced that "travel even within our country adds a great deal to our education obtained in the College".

Atanacio T. Carandang, '20, is at present an assistant sugar cane investigator of the Pampanga Sugar Development Company. Mr. Carandang was formerly a graduate assistant in the Department of Agronomy in this College.

Maximo P. Canonizado, '20, is a supervising teacher of the Bureau of Education stationed in Pagsabañgan, Tagum, Davao. He is in charge of twelve settlement farm schools. He writes that he likes his job very well. He deals mostly with Moros, Mandayas, and Aetas.

Lieutenant Nemesio Catalan, '20, visited the College on December 17, 1922. Mr. and Mrs. Catalan were in Los Baños with their family on the occasion of the town fiesta held on December 16th. Mr. Catalan is now stationed in Fort McKinley, and he says that he is enjoying his work in the army.

Catalino S. Rayos, '22, is at present teaching in the Pangasinan High School. He intends to go to private farming as soon as he accumulates enough capital to start with.

Francisco Mendoza, '22, is now assistant in Sugar Cane Investigations for the Philippine Sugar Centrals Agency. He is at present stationed in Isabela, Negros Occidental.

Vito C. Rada, a former student of this College, addressed the College of Agriculture Alumni Association at its meeting held January 9, 1923. Mr. Rada talked about his experiences in his work with the Bureau of Education. He also dealt with the work of farm schools in their relation to the work of the College of Agriculture. Mr. Rada is now a teacher in the Batangas Farm School. He is planning to continue his studies here next June.

ERRATUM

THE HERPETOLOGICAL FAUNA OF MOUNT MAKILING

By Edward H. Taylor

A line was omitted in the last sentence of the addendum of the paper entitled "Herpetological Fauna of Mount Makiling" by Edward H. Taylor in the December issue (Philippine Agriculturist XI 5, page 139). The last line should read "..... one lizard, *Gonyocephalus semperi* Peters and a small snake *Calamaria bitorques* Peters."